

REMARKS/ARGUMENTS

During the interview the below signed attorney noted that the finality of the office action is premature since the examiner has raised new grounds for rejecting the claims which were not necessitated by applicant's previous amendment. Accordingly, applicant submits that the finality of the office action should be withdrawn. However, it is to be noted that this is most likely a moot point in view of the examiner's indication during the interview that the present amendment should result in allowance of the application.

The examiner has objected to claims 1, 4, 5, 7, 8, 10 and 12 in item 7 of the office action and has raised various grounds for rejecting the claims in items 9, 11, 12 and 13 of the office action. Before discussing the various issues raised by the examiner in the aforementioned objections and rejections, the below signed attorney first wishes to thank the examiner for the courtesy extended to the below signed attorney during the interview on October 27, 2003. The following remarks constitute a separate summary of the substance of the interview as well as additional comments in support of the patentability of the claimed invention.

It was emphasized by the below signed attorney during the interview that applicant's invention pertains to improved reinforcing and processing fibers which are useful in the fabrication of friction linings and gaskets. The fibers of the invention are vegetable fibers (i.e., fibers obtained from vegetation such as flax, hemp, sisal, jute or ramie). The improvement relates to the treatment of the fibers to obtain a high degree of fibrillation so that the fibers of the invention (either reinforcing fibers or process fibers) can substitute for fibrillated aramid fibers in many applications (see page 3, lines 9-11).

It was noted during the interview that the vegetable fibers which are improved in accordance with the present invention include "bast fibers" which are composed of fibers in which plural elementary fibers are combined into fiber bundles (see page 1, lines 9-13). It is these elementary fibers of the bundles which are fibrillated. In this regard it is noted on page 1, beginning on line 13 that fibrillation is a process where the elementary fibers are split open into finer fibers which are known as "fibrils". The degree of fibrillation of the elementary fibers is related to the number of fibrils which are formed along the length of the elementary fiber. It is noted on page 9, lines 14-16 that "the degree of fibrillation indicates which fraction of the length of an elementary fiber has fibrils". A method for determining the degree of fibrillation, measured in percentage, is described in the paragraph on page 9 under the heading "Degree of Fibrillation". It is self-evident from this description that the portion of an elementary fiber which has fibrils extending therefrom can vary from 100% to a content or fraction thereof which is less than 100%. Other measurements of the content or fraction of the fibrils are described in the specification. In particular, it is noted in the paragraphs which appear under the heading "Fractions of Fibrils" on page 9 of the specification that the measurement of the fibril fraction provides an accurate method for determining the amount of fibrillation of an elementary fiber. This portion of the specification describes the measurement of fibril fraction which is expressed in units of area percent. The degree of fibrillation expressed in the claims is given in units of "area percent".

In view of the above, it is clear that applicant's invention pertains to vegetable fibers which have been fibrillated to produce a high number of fibrils along the length of the elementary fibers. In claim 1 the high degree of fibrillation is recited as being greater than 3 area percent and less than 50 area percent.

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Thus, it is the level of fibrillation of the claimed fibers which is important in the present invention.

Turning now to the issues raised by the examiner, the examiner has objected to claims 1, 4, 5, 7, 8, 10 and 12 in item 7 on the grounds that the claims are grammatically incorrect and confusing. During the interview the examiner indicated that the confusion from the claims arises from the use of the term "content" in the claims to describe the above-described high degree of fibrillation which characterizes the present invention. The examiner agreed that changing "fibril content" to "fibril fraction" will overcome this objection. Accordingly, applicant has amended the claims by replacing the term "fibril content" with "fibril fraction". However, applicant submits that the original term "fibril content" implicitly refers to the fibril fraction since the term "content" as used in the context of applicant's invention clearly refers to the part or fraction of the elementary fibers which have fibrils and thus the term "fibril fraction" as currently recited in the claims merely clarifies that which was clearly implicit in the original wording.

The examiner agreed during the interview that the above-discussed amendment will result in withdrawal of the objection to the claims.

The examiner has rejected claims 4 and 5 under 35 U.S.C. § 112, second paragraph, as being indefinite. In this regard the examiner urges that claims 4 and 5 are unclear because it is not clear whether or not the fibers recited in the claims refer to vegetable fibers or the aramid fibers. Applicant has amended claims 4 and 5 to make it clear that the fibers being referred to are the vegetable fibers. In this regard it is to be noted that claims 4 and 5 originally recited that the fibers are the fibers according to "claims 1 or 2" which are indeed the vegetable

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fibers. Furthermore, it is clear from the specification that the fibers of the invention pertain to vegetable fibers and in this regard it is noted on page 3, lines 23-26 that the limitations referred to in claims 4 and 5 refer to the fibers of the invention (i.e., the vegetable fibers).

It was also agreed during the interview that the term "comprising" in claim 1 and in some of the other claims should be changed to "wherein". Accordingly the term "comprising" has been replaced by "wherein" in claims 1, 2, 4, 5, 7, 8, 10, and 17.

In addition to the above-discussed substitution of "wherein" for "comprising" applicant has made a few additional minor changes in the wording of the claims to further improve their language.

The examiner has rejected claims 1-5, 11, 13 and 17-18 under 35 U.S.C. § 103(a) as being unpatentable over Ikuta. In rejecting the claims the examiner acknowledges that Ikuta does not disclose that the fibers have a fibril content greater than 3 area percent and less than 50 area percent. However, the examiner urges that since 5-70% of the fiber is fibrillated, it would follow that 3-50 area percent would be included in Ikuta's range. Also the examiner further notes that the fibril content increases the wear resistance and it would be obvious for one skilled in the art to use the recited fibril content in order to increase the wear resistance of the fiber mixture. Applicant has carefully considered this rejection but it is most respectfully traversed for the reasons discussed below.

As noted during the interview, the present invention relates to the degree of fibrillation of the elementary fibers. Ikuta is silent on the degree of fibrillation. Instead, Ikuta is only concerned with paper-like friction material which is

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characterized by the amount of fibrillated fiber contained therein. In particular, Ikuta states in column 1, lines 30-33 that his paper-like friction material is characterized by containing 5 to 70 weight percent of fibrillated ramie fibers with a freeness of 400 to 700 ml. Ikuta makes absolutely no disclosure regarding the degree of fibrillation utilized in the fibrillated ramie fibers which he includes in his paper-like friction material. The fact that Ikuta uses 5-70% of the fibrillated ramie fibers in his paper provides absolutely no disclosure or teaching regarding the degree of fibrillation of his fibrillated fibers.

The examiner agreed with this analysis during the interview and indicated that Ikuta does not disclose or suggest vegetable fibers having the high degree of fibrillation required by applicant's invention.

It was also emphasized by the below signed attorney during the interview that not only does Ikuta fail to disclose or suggest highly fibrillated vegetable fiber, he teaches against the fibers of the present invention. In this regard it was emphasized that contrary to the examiner's observation, Ikuta does not teach that the wear resistance can be improved by a higher fibril content. Instead, Ikuta states that the wear resistance is improved by a fibrillated ramie fibers with a freeness of 400 to 700 ml (see column 1, lines 32-33). In the papermaking industry, the freeness of the pulp is an important characteristic since it is critical to the drainage properties on the paper machine. The pulp freeness is the rate at which water will drain through the pulp. See attached abstracts of *Ullmann's Encyclopedia of Industrial Chemistry*; and "Refining and Pulp Characterization" published in the internet at www.wmich.edu/ppse/pekarovicova/210999a.html. In North America the freeness is usually the Canadian Standard Freeness (CSF).

In the papermaking process the plant fibers are stripped from their non-cellulosic associates. This is usually done by chemical or biological degradation. Then the fibers are cut in order to reduce the fiber length. Further, the fibers are swelled by watering them and decurled. Finally the fibers may be fibrillated and fines may be produced. The surface of the fiber is initially relatively smooth. The beading of the fibers causes bits of the fiber surface to come loose, increasingly giving the surface the appearance of having grown hairs. These hairy surface outcroppings are called fibrils, and the manner of their occurrence is described as fibrillation. If the beading action is sufficiently severe or prolonged, the surface fibrils can be totally dislodged from the fiber, becoming very small particles which are free to wander around. These separated fibrils are called fines. It is the fibrillated surface of the fibers and the Independent fines which are largely responsible for the drainage characteristics of the stock of the paper makers mold or on the wire of a paper machine. The more fibrillation and the more fines are produced, the slower water will pass through the forming mat. **This means that the more the fibril the content is (i.e., the more the fibers are fibrillated) and the more fines are present, the lower the freeness will be.** This is clearly evident from the attached publication "Science for Handpapermakers" by W.F. Cowan, published at www.sewanee.edu/Chem&Art/Detail_Pages/Paper/Science_for_vol2.htm

Ikuta clearly teaches that the **value of freeness shall be high** (see column 1, line 43). This means that the degree of fibrillation of the ramie fibers utilized by Ikuta must be kept low, not high as in applicant's invention. Thus it is self-evident that Ikuta clearly teaches away from the present invention because the present invention requires highly fibrillated fibers (see page 3, line 9 of applicant's specification) whereas Ikuta requires fibers with a high freeness value which is associated with a low fibril content. Accordingly, there would be no motivation for

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one skilled in the art to ignore Ikuta's requirements for high values of freeness (low degrees of fibrillation) to produce a highly fibrillated fiber wherein the freeness value will be lowered.

In view of the above, it is clear that Ikuta does not disclose or suggest the highly fibrillated fibers of applicant's invention. Thus, the rejection of the claims under 35 U.S.C. § 103(a) as being unpatentable over Ikuta must be withdrawn.

The examiner has rejected claims 1, 6-8 and 19-20 under 35 U.S.C. § 103(a) as being unpatentable over Ikuta in view of Kolla et al. In rejecting the claims the examiner has relied upon Ikuta for the same reasons noted in the above-discussed rejection. In rejecting the claims the examiner acknowledges that Ikuta does not disclose a mixture of vegetable fibers and shives. The examiner turns to the teaching of Kolla for this aspect of the invention. Applicant submits that modifying Ikuta by the inclusion of shives will not result in the claimed invention in view of the shortcomings of Ikuta discussed above.

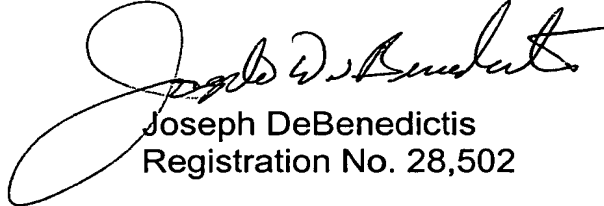
The examiner has rejected claims 1, 9-10 and 12 under 35 U.S.C. § 103(a) as being unpatentable over Ikuta in view of Holinski. The examiner relies upon Ikuta for the same reasons discussed above and urges that it would be obvious to arrive at the claimed invention by including the metal sulphides disclosed by Holinski. Applicant submits that this rejection should also be withdrawn since it is clear from the above discussion of Ikuta that incorporation of the metal sulphides with the fibers of Ikuta will not result in applicant's invention in view of the shortcomings of Ikuta.

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In view of the above comments and amendments to the claims, favorable reconsideration and allowance of all of the claims present in the application are most respectfully requested.

Respectfully submitted,

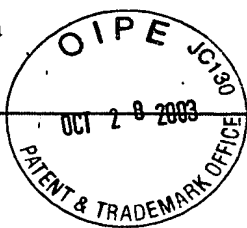
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REFINING AND PULP CHARACTERIZATION

Refining – mechanical treatment of pulp fibers to develop their optimum papermaking properties. Refining increases the strength of fiber to fiber bonds by increasing the surface area of the fibers and making the fibers more pliable to conform around each other, which increases the bonding surface area and leads to a denser sheet. Generally a refining is a trade-off between improving fiber to fiber bonding and decreasing the strength of individual fibers. Most strength properties of paper increase with pulp refining, since they rely on fiber to fiber bonding. The tear strength, which depends highly on the strength of the individual fibers, actually decreases with refining. Refining of pulp increases their flexibility and leads to denser paper. This means bulk, opacity, and porosity values decrease with refining.

Fiber Brushing - refining at high consistency with a relatively large distance between the refiner plates increases fiber-fiber interactions that are termed fiber brushing. This tends to roughen the fiber surface, with minimal fiber cutting for improved fiber-fiber bonding.

Fiber Cutting - Operating refiners at low consistencies with a minimal distance between the refiner plates increases fiber-bar contact, resulting in fiber cutting. This is desired with long-fiber pulps (redwood, cotton etc.) to increase the quality of formation on the paper machine. In most cases, however, it is desirable to minimize fiber cutting to maintain high paper strength.

Drainage – is the ease of removing water from pulp fibers, either by gravity or mechanical means. CSF is a measure of drainage and a useful means for determining the level of refining.

Fibrillation – production of rough surfaces on fibers by mechanical action; refiners break the outer layer of fibers, i.e., the primary cell wall, causing the fibrils from the secondary cell wall to protrude from the fiber surfaces. For example, the surface area of kraft, softwood fibers is on the order of $1\text{m}^2/\text{g}$ at 750 CSF, but it increases to about $5\text{m}^2/\text{g}$ at 350 CSF.

Average fiber length – statistical average length of fibers in pulp. Fiber length is measured microscopically (number average), by classification with screens (weight average) or by optical scanners - Kajaani (number average). The coarseness of fibers has an important effect on many properties of paper. Coarseness is defined as the weight per unit length of fiber expressed as milligrams per 100 m.

Pulp used to be treated in beaters, such as the Hollander beater, but now refiners are used. The terms beating and refining are often used interchangeably, but refining is applicable to most modern equipment.

Canadian Standard Freeness, CSF – the CSF test was developed for use with groundwood pulps and was not intended for use with chemical pulps; nevertheless, it is the standard test for monitoring refining in North American mills. Refining decreases the pulp freeness, the rate at which water will drain through the pulp. Refined pulp, therefore, has a low freeness. A high drainage rate also means a high freeness. Obviously freeness is of utmost importance in the operation of a paper machine. A

low freeness means that the paper machine will have to operate relatively slowly, a condition that is usually in tolerable. There are other freeness tests that are used around the world. Perhaps the most common one is the Shopper Riegler test, which is similar in concept to the CSF test. CSF results depend on the temperature and consistency.

2.3.2.5. Production Processes

Raw material processing and fiber production in the wet and dry processes are very similar, frequently even identical.

Raw Material Processing. The wood used is predominantly roundwood, also partly debarked chips from sawmills or whole-tree chips. Pieces of bark are generally undesirable. They contain minerals that shorten the service life of refiner disks and processing tools, and impair surface quality.

Roundwood is generally debarked before chip production. This can be carried out by using ring or drum debarkers.

Chips are most frequently produced by using disk chippers or cylinder chopping machines. The cutting disk of the disk chipper, arranged vertically or diagonally, is fitted with 4–16 blades, depending on the size. The positions of the blades determine the dimensions of the chips.

Fine chips (<4-mm sieve mesh) and coarse chips (>40-mm sieve mesh) are separated from normal chips by sieving on flat or drum sifters. The fine chips are incinerated, and the coarse ones are cut up further in hammer or wing beater mills. The optimum chip size is 20–25 mm × 20 mm × 5 mm.

To remove foreign material and mineral components, chips are washed before further processing. This is particularly important with whole-tree chips. Washing is carried out in specially designed plants with prewashers for separating coarse components and a screw drainer for separating fine mineral particles. The chips are then stored in reinforced concrete or metal silos. Storage acts as a buffer between chip and fiber production and at the same time allows the moisture distribution to become more uniform.

Fiber Production. The aim of defibration is to break up the previously chopped raw material as carefully as possible into individual fibers and bundles of fibers. This is carried out thermomechanically. The lignin-rich middle lamellae that bind the fibers are first softened by heat and steam. The fibers are then separated by mechanical abrasion. They are often broken in the process, giving fiber fragments. The anatomical nature of the fibers and their state after defibration are important for forming the fiber mat and for the properties of the board. This applies particularly to the wet process in which the freeness (draining behavior) and the type of matting are very important.

Thermal treatment of the chips before and during defibration causes part of the hemicelluloses to go into solution. Increasing the temperature and the length of the treatment period leads to increased softening of the interfiber bonding. In the wet process, this improves the natural adhesion between fibers during board production. At the same time, the sugar content of the wastewater and the energy consumption increase, so that a compromise between environmentally friendly and economic process design and board properties is usually aimed at. Fiber production is energy intensive; it consumes more than half of the total process energy. Table (10) gives an overview of important current fiber production processes.

In the *Masonite process*, both the softening of fiber bonds and the separation of fibers are effected by steam. This technique is used exclusively in the United States by the Masonite company (wet process).

Refiners. In all other processes defibration is carried out by using grinding disks. Some defibrators operate at atmospheric and others at elevated pressure. Also, machines exist with only one rotating grinding disk (Sunds) or with two counterrotatory disks (Sprout-Bauer).

Refiners operating at atmospheric pressure have the disadvantages of high energy consumption

and moderate quality of the fibers produced.

The refiner now used predominantly, which operates under pressure, gives better results. The Asplund defibrator (Sunds) is a prototype. This makes use of the fact that from ca. 170 °C, separation of fibers in the middle lamella is considerably easier and is associated with a significant lowering of the energy consumption and an improvement in fiber quality.

In the defibration process (see Fig. (30)), washed chips are fed into the preheater through a conical opening using a screw feeder (c). The preheater (e) is usually a vertical, slightly conical pressure container, which is continuously charged with saturated steam at 150–180 °C. The steam heats the chips by condensation. Blowing steam out through the opening is hindered by the plug formed in it by the chips (d).

In 1–3 min the chips reach a conveyor screw (g) at the base of the preheater through which they are transferred to the grinding disks of the refiner (h), where defibration takes place under steam pressure. The necessary grinding power is ca. 200 kW per tonne of dry fiber.

The important parameters affecting the quality of the fiber material and the energy consumption are the residence time and vapor pressure in the preheater, throughput quantity, defibrating pressure, distance between grinding disks (0.1–0.4 mm), number of revolutions per minute, state of the grinding disk, nature of the raw material, and moisture level.

Defibration is tested by determining the degree of grinding or by fractionating the fiber material. The degree of grinding is a measure of the freeness of the fiber material and determined by means of the dewatering speed of a fiber suspension (standard freeness tester, defibrator-seconds, DS). In the wet process, higher degrees of grinding usually result in an improvement in board properties.

After defibration fibers are blown out through a pressure-regulated exit valve. From this stage onward the wet and dry processes differ and are described separately below.

Wet Process. A fiberboard production plant using the wet process is shown schematically in Figure (31). The fiber material is fed to silos (b) for mixing and adjusting concentration (4–6 %) or is further defibrated in disk refiners (f). For hard and semihard fiberboards a degree of grinding of 18–30 DS is aimed at, and for porous boards 42–70 DS [60].

A system of tanks and conveying devices is used for mixing, storing, and addition of adhesives and additives (see Section 2.3.2.4. Binders and Additives). A control panel connected to the system regulates concentration, temperature, and pH.

The fiber mat is formed on a sieve by drainage of water from the fiber suspension and subsequent sedimentation of the fibers. Mat formation was previously carried out as a batch process in tanks, but cylinder wet machines and conveyor sieve dewatering machines are predominantly used now. The main component of the latter is a continuously moving sieve.

Fiber material is added through a headbox at a concentration of 1–2 % and is subsequently drained and compressed by means of a forming table, suction box, and wet pressing section.

To improve the surface properties of the smooth side of the fiberboard, fiber material of higher quality can be applied to the mat on the forming table through a second headbox. After the wet press the thickness of the mat is 20–25 mm, which gives a final thickness of 3–5 mm. The mat is then separated into individual sections corresponding to the pressed board format of the hot press.

In the production of *softboard* or *S2S hardboard* by the wet process, the drained fiber mats are dried in single- or multideck dryers at 150–170 °C from moisture levels of 100–120 % to 1–4 %.

To prevent dried boards from catching fire during subsequent storage, they are cooled

immediately after drying by spraying with water and aspiration of ambient air.

S1S board is further dewatered in hydraulic multi-daylight presses by hot pressing using an established pressure–time program, compressed, and strengthened by curing the binders that are naturally present or have been added. For S1S, use of a draining sieve is necessary to remove the large quantities of water. For hardboard the pressing time is generally 2.0–3.5 min/mm at a pressing temperature of 180–200 °C. A typical pressing diagram consists of three phases, the compression and first high-pressure stage, drying, and the second high-pressure stage.

An improvement in the properties of fiberboard can be effected by thermal aftertreatment in chambers or continuously in tunnels or by impregnating with drying oils (see Section 2.3.2.4. Binders and Additives). Treatment results in a more uniform moisture distribution in the board as well as better dimensional stability.

Dry Process. The production of MDF is shown schematically in Figure (32). After defibration (g) the fibers pass down a blow line in which glue (see Section 2.3.2.4. Binders and Additives) is added and then reach the fiber dryer (i). Alternatively, they can be blown directly into the fiber dryer (i) by making use of the vapor pressure present in the refiner. In this case they are subsequently glue-blended in high-speed centrifugal machines, as in particle board production. In almost all plants, glue blending occurs before drying, thus avoiding spots of adhesive on the board surface that impair its quality. Paraffin added to improve hydrophobic properties is generally charged in the molten state to the lower conveyor screw of the refiner.

Tube dryers are now used exclusively for drying the fibers. They are mostly two-stage dryers with tube lengths of 80–100 m and diameters of 1.3–1.6 m. The air temperature at the entry is 140–170 °C. Because of the high air speed (ca. 30 m/s) and the small dimensions of the fibers, the drying time is only a few seconds [61]. The moisture level of the fibers is adjusted to 9–11 % by regulating the exit temperature of the dryer.

The fibers reach the forming station (m) via cyclones and fiber hoppers (j). The fiber mat is formed either mechanically by using a snowfall felt or pneumatically by using a pendistor on a vacuum screen conveyor.

The uniformity of distribution of the fiber material over the surface of the screen significantly affects fiberboard properties.

The mat coming out of the forming station has a very low bulk density and contains a large quantity of air, which must be removed before hot pressing. To decrease the size of the press opening, shorten the closing times of the hot press, and improve the transportability of the mat and the surface quality of the finished board, the mat is precompressed in continuously operating belt prepresses. Mat density is thus doubled or trebled.

Hot pressing of the fiber mat occurs either batchwise on multi-daylight presses with preliminary separation into mat sheets or, as is now increasingly common, continuously on double-belt presses or calenders for thin boards (up to 8-mm thickness). The presses are the same as those used for particle board production (see Section 2.3.1.5. Production). To heat the fiber mat more rapidly and shorten the pressing time, the fiber mat is often subjected to high-frequency preheating before entering the hot press. Pressure control in MDF production differs from that in particle board production. Figure (33) gives an example of the pressure program.

The bulk density profile (perpendicular to the board thickness) and thus the properties of the board can be widely varied through the type of compression and the temperature control. High compression in the outer zones and as uniform a density as possible in the inner zones are aimed at (see Section 2.3.2.6. Properties, Testing, and Uses).

[60]

H. Lampert: *Faserplatten*, VEB Fachbuchverlag, Leipzig 1966, 453 p.

[61]

G. Gran, *Holztechnologie* **28** (1987) 143–146.

2.1.2. Characteristics Required of Mechanical Pulps

About 90% of the mechanical pulp produced is used to make graphic papers, such as newsprint; uncoated and coated magazine papers, e.g., SC (super calendered); and LWC (light weight coated) papers [251]. The desired properties of mechanical pulps, used for graphic papers, are as follows:

- 1) The mechanical pulp should contribute substantially to the structural strength of the paper. Newsprint, for example, may contain more than 80% mechanical pulp.
- 2) The printability of the paper is mainly determined by the quality of the mechanical pulp.
- 3) Since graphic paper is usually printed on both sides, a very low show-through and strike-through of the printing ink is very important. In offset printing, the surface of the paper should have a high picking resistance and be free of dust.
- 4) The drainage ability (freeness) of mechanical pulp has to be high to allow the paper machines to be operated at high speeds (ca. 1400 m/min). Furthermore, the paper has to be able to cope with the stresses within the printing machines.

The technological data of mechanical pulp is determined by means of standardized test methods. The United States and its neighbors follow the TAPPI regulations [252], the Scandinavian countries use the Scan methods [253], and Germany and its neighbors, the Zellcheming regulations [254].

Although the methods used vary and the results are thus not directly comparable, all standards require determination of the following mechanical pulp properties:

- 1) Drainage characteristics (e.g., freeness)
- 2) Stability properties such as tensile strength tearing strength, and picking resistance
- 3) Optical properties such as brightness and opacity
- 4) The quantitative composition with respect to the portions of long fibers, fiber fragments, and fines as well as the size of the shives

Furthermore, proof printing and other tests provide information about the suitability of a mechanical pulp.

All in all, the test methods in question permit adequate assessment of the mechanical pulp and are essential for mechanical pulp production.

⇒ Continued ...

[251]

"Holzstoff—Halbstoff mit Zukunft," *Papier (Darmstadt)* 37 (1983) no. 10 A, V 11.

[252]

American National Standards, Tappi, Atlanta 1989.

[253]

Scan Norm, Testing Committee, Stockholm.

[254]

Merkblatt VI/1/66, Verein der Zellstoff- und Papier-Chemiker und -Ingenieure, Darmstadt.